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Description of Proposed Alternatives

North Delta Flood Control and
Ecosystem Restoration Project

Levees and North Delta Branch
Bay-Delta Office
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Document Purpose

This document details the four North Delta Flood Control and Ecosystem Restoration Project alternatives that are under consideration to be taken forward for detailed impact analysis in the project EIR. This is a challenging project to achieve well-integrated ecosystem restoration and flood control within a complex system and provide additional enhancements such as recreation and conveyance benefits to the extent possible. Although much refinement is still necessary within the proposed alternatives, preliminary analysis such as hydraulic modeling, have indicated that these general concepts hold the greatest promise for achieving project goals. All proposed alternatives include several common components including opening McCormack-Williamson Tract to flood and/or tidal flows. In each alternative, these common components are coupled with various potential components to address the downstream flood capacity needs from opening up McCormack-Williamson Tract, such as detention basins, dredging, or short setback levee sections which have potential to provide the needed capacity without being cost prohibitive. To meet political constraints, no alternative would change the FEMA 100-yr floodplain.

There is much uncertainty regarding the viability of dredging due to current regulatory conditions. Therefore, each alternative is presented with a scenario that precludes dredging (and relies solely on other components such as detention basins to provide required downstream capacity) and a scenario that includes dredging. The scenarios that include dredging allow more flexibility in project phasing as upstream components can be implemented incrementally along with incremental dredging to address the increased downstream capacity necessitated by upstream changes. The table below illustrates the naming convention for the scenarios throughout this document.

Table 1: Naming Convention of Alternatives

ALTERNATIVE DESCRIPTION	NAMING CONVENTION	
	No Dredging	Dredging
North Staten Island Detention	1	1D
North Fork Detention	2	2D
South Fork Detention	3	3D
Dredging and Levee Raising	N/A	4

The source of existing elevation data is from the North Delta Study geodatabase on the DWR GIS server dated 1995 (revised in 2000). All elevations are related to the National Geodetic Vertical Datum of 1929 (NGVD29) in units of feet, unless specified otherwise. The data is located in the p_delta_public database connection under jdudas.elevation, and the feature class is named “contours_north_delta_study”. The contours were generated from photogrammetry data. Proposed changes to the existing topography through levee degradation, levee construction, ecosystem restoration components and weir construction are related to Mean Sea Level Datum, which can be equated to the National Geodetic Vertical Datum of 1929. No conversion is necessary when comparing existing elevations to proposed elevations for various alternative actions.

Proposed Alternatives for EIR EIS Impact Analysis

The following subsections specify the components of each alternative selected for detailed impact analysis. The purpose is to provide adequate information so that an accurate impact analysis of the selected alternatives can be performed. Since this project is still in the planning phase, some components of the alternatives are not yet clearly defined. Future reports will detail components that have not fully been developed.

Common Components

Some components considered for the project are incorporated into each of the alternatives that are to be taken through impact analysis. The purpose of this subsection is to describe the components. The following list describes all common components and is followed by a detailed description of each:

- Degradation of McCormack-Williamson Tract east and southwest levees
- Hardened weir structure on degraded M-W Tract east levee
- Wildlife-friendly levees
- Breaches along M-W Tract Mokelumne River levee
- KCRA-3 protective levee
- KCRA-3 alternate road access

Extensive hydraulic modeling shows the necessity to degrade a portion of the east and southwest levees on M-W Tract to achieve desired flood control benefits in the upper portion of the project area measured by stage reductions at Benson's Ferry. Since the North Delta study area is limited by channel capacity, overtops the east levee on M-W Tract, which is legally restricted in height and the levee fails during large storm events. M-W Tract fills and causes the southwest levee to breach catastrophically, causing a surge effect downstream which displaces boats and precipitates further levee failures, etc. Lowering the elevation of the M-W Tract levees would allow flow to move through the system in a controlled manner, eliminating this "surge" effect. This action would convey flood flows more efficiently, potentially causing downstream stage impacts. Each alternative addresses potential downstream impacts with components such as detention basins, setback levees, dredging and raising existing levees.

The east levee of McCormack-Williamson Tract would be lowered to allow flood flows onto the tract. 3000' of the east levee would be degraded to an elevation of 8.5' (from an existing elevation of 17'-18'). The landside of the levee would be reinforced with roller compacted concrete mixed with dirt, set at a low slope (5:1) and naturalized to be in a natural wavy pattern. The McCormack-Williamson Tract southwest levee would be degraded along the entire length of Dead Horse Cut to an elevation of -2.5' (from an existing elevation of 15'). The interior of all McCormack-Williamson Tract levees (where there are no breaches or it is not otherwise inconsistent with one of the proposed ecosystem restoration scenarios described below) would be low-slope (5:1) wildlife-friendly levees. These levees would protect the McCormack-Williamson Tract from erosion when the Tract is flooded.

Ecosystem restoration scenarios for McCormack-Williamson Tract are being refined and will be further detailed shortly in a subsequent draft of this report. Topographic and

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other characteristics of McCormack-Williamson Tract present unique potential opportunities for integrating one or more of the following with flood control components:

- Avulsed channel through McCormack-Williamson Tract created by breaching a northeast levee section adjacent to the Mokelumne River and diverting the river through McCormack-Williamson Tract. Could include an excavated meandering channel on McCormack-Williamson and a small rock dam in existing channel just below the breach to encourage flow into tract.
- Floodplain habitat created by multiple breaches on the east levee section adjacent to the Mokelumne River. Breaches would be designed and located to maximize sand splay and effectiveness of sediment capture.
- Intertidal and subtidal habitat created by full degradation of southwest levee. Northernmost portions of wild-life friendly levee (enhancing internal erosion control) on east of McCormack-Williamson may be optional if flood relief lowers stages enough.
- Intertidal habitat and subsidence reversal created by leveeing off the southern tip of McCormack-Williamson and allowing tule habitat to develop within the southern tip and lowering a section of the west levee along Snodgrass Slough to high tide level to allow intertidal habitat development.

All alternatives include degrading the east and southwest levees on M-W Tract, allowing the parcel to serve as a floodway during high flows. The Nature Conservancy (current landowner of M-W Tract) has an existing lease with Hearst-Argyle Television Co (KCRA-channel 3) on a parcel in the northwest portion of the Tract that requires all alternatives to maintain the current level of flood protection on the leased property and road access with no additional flood risk.

Maintaining the current level of flood protection on the leased property requires a protective levee around a portion or all of the leased property. The levee must protect the tower and the building, but it is still unclear whether the levee must surround the guy wires and anchors as well. Department of Water Resources (DWR) is in the process of analyzing whether inundating M-W Tract more frequently, and in turn, inundating the guy anchors and possibly wires more frequently has an adverse impact on these components of the transmission tower structure. To complete this analysis, we must determine the frequency of inundation for all project alternatives, as well as the duration of inundation and the water surface elevation in the vicinity of the guy wires and anchors during periods of inundation. The length of the levee will range from 2250'-4000', depending on the outcome of the structural analysis (Refer to Figure 4 for protective levee alignments). The elevation of the levee is to be high enough to prevent water from inundating the structures more frequently than the current level of protection (TBD).

To be able to degrade the M-W Tract east levee and maintain road access to KCRA with no additional flood risk, a hardened weir structure along the 3000' degraded portion of the east levee would be constructed. This would provide alternate access to the leased property, as illustrated in Figure 5. Based on negotiations between KCRA-3 and The Nature Conservancy (TNC), it is our understanding that the modification to the east levee described above is acceptable as alternate road access. Maintaining an elevation of 8.5' on the east

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levee would assure no additional flooding occurs, with respect to the current road access flood risk. This is based on the lowest elevation of the current road access, which is 8.5' along the Mokelumne River levee (Refer to Figure 6).

Dead Horse Island is under consideration for flood control and /or ecosystem restoration benefits and further modeling will determine the benefits of this island as a component of the alternatives. The existing elevation of the east levee on Dead Horse Island is 15' and the west levee elevation slopes from 13'-15'. A possible flood control enhancement would include degrading the east and west levees to provide better conveyance through the system.

North Staten Island Detention

Alternative 1

Alternative 1 includes all common components described above and a detention basin on the northern end of Staten Island. Figure 7 illustrates the components of this alternative. Degrading M-W Tract levees would provide better conveyance in the upper portion of the system and the detention basin is the flood control measure for addressing potential downstream impacts. Table 2 lists all components of alternative 1.

Table 2: Alternative 1 Components

COMPONENT DESCRIPTION	
1	KCRA-3 protective levee
2	Degrade M-W Tract east and southwest levees
3	Raise/realign county road on Staten Island
4	Millers Ferry Bridge replacement
5	New Hope Bridge replacement
6	Cross levee for detention on Staten Island
7	Pumps for detention basin waters
8	Inlet weir on Staten Island
9	Protective levee for home and barn on Staten Island
10	Protective levee for grain dryer on Staten Island
11	Breach levee on northern tip of Staten Island
12	Internal detention levee(s) on Staten Island
13	Degrade Dead Horse Island east and southwest levees*

*Modeling and analysis is necessary to determine whether this component will be included in the alternative.

Flows would be conveyed from M-W Tract (and possibly Dead Horse Island) to Staten Island by degrading the northern levee on Staten Island from an existing elevation of 15' to a lower elevation (TBD through iterative HEC-RAS modeling). A weir would be constructed along the county road to allow flood flows to enter the detention basin in high flow events. Although the weir height and corresponding flow frequency it will allow to pass must be refined, in no case will the detainment area capture flow from events less than the 10 year flood event. As well, due to political constraints, the basin will not be able to

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detain flows greater than or equal to the 100 year flood event. The detention basin capacity will be designed based on the 1997 flood event (Note: DWR Flood Management staff is performing an analysis to verify that this event is less than the statistical 100 year flood event as it relates to FEMA floodplain mapping). The required acreage for the detention basin has not yet been determined. Additional HEC-RAS modeling will be done to size the basin for the 1997 event while minimizing required acreage and frequency of inundation. An internal cross levee would be designed to detain peak flood flows for the 1997 flood. Additional internal levees within the larger detention area could detain peak flows during lesser events (e.g. 10, 25 and 50 year events) within a smaller portion of the island. Once all the details of the detention basin size, weir elevation and length have been determined, an appendix in addition to this report will detail the detention basin configuration. In the event that the basin fills, permanent or portable pumps would operate to pump the water out of the detention basin after the flood event.

The county road would have to be raised to accommodate the construction of weir that will follow the same alignment as the roadway. It is also possible that the road would also be realigned to minimize the length of raised roadway/weir that will be required. (The Department of Water Resources has been consulting with San Joaquin County Engineers to define modifications to the existing roadway.) Miller Ferry Bridge and New Hope Bridge replacements may be necessary to allow for construction of weir and to accommodate a potential realignment of the county road. Also, both bridges have historically been constriction points in the system during flood events. Bridge replacements should provide relief at these areas of constriction in future flood events. Protective levees around the grain dryer, home and barn on Staten are necessary for this alternative to protect existing infrastructure that is vital to the agricultural operation on Staten Island, unless another option becomes available, such as relocation.

Alternative 1D

All components described in alternative 1 apply to alternative 1D to the extent necessary, with the addition of the dredging component. The benefits of including dredging as a flood control component are that this alternative has the potential to be phased and a smaller detention area than in alternative 1 is necessary due to increased channel capacity from dredging. A drawback of including dredging and sizing the detention basin smaller than in alternative 1 is that dredging to increase channel capacity is a solution that may not last the entire project life and there are no assurances that additional dredging permits would be approved to maintain the necessary channel capacities to meet flood control goals.

It is proposed that alternative 1D be implemented through phasing with a maximum of three project phases prior to completion (Refer to Table 3). Viability of proposed project phasing needs to be verified through HEC-RAS modeling as each phase must adequately address hydraulic impacts. Components of each phase are specified in Table 3 in the necessary order of completion.

Dredging would increase channel capacity in locations where sedimentation has occurred, thus reducing channel capacity. The dredged material is to be used for levee construction and ecosystem restoration. The locations, quantities, and phasing of dredging are detailed in Appendix A (Refer to Appendix A2 for dredge locations and Appendices A3-

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A5 for quantities). Dredging proposed during the first phase of each alternative would include a portion of the Mokelumne, Snodgrass Slough and Dead Horse Cut, totaling approximately 31,276 feet of river channel and 4,498,962 cubic yards of material. Studies performed during this process will determine whether dredging will occur during phase 3 of the project. Given that dredging in the first phase of the project goes as planned, the third phase dredging component includes the Mokelumne River above the demonstration project and the South Fork Mokelumne River below the demonstration project. Approximately 41,600 feet of river channel and 4,574,471 cubic yards of material are to be dredged during the final phase of the North Delta Flood Control and Ecosystem Restoration Project.

Table 3: Alternative 1D Components and Project Phasing

	COMPONENT DESCRIPTION	PROJECT PHASE		
		1	2	3
1	Phase 1 Dredging	●		
2	KCRA-3 protective levee	●		
3	Degrade M-W Tract east and southwest levees	●		
4	Raise/realign county road on Staten Island		●	
5	Millers Ferry Bridge replacement		●	
6	New Hope Bridge replacement		●	
7	Cross levee for detention on Staten Island		●	
8	Pumps for detention basin waters		●	
9	Inlet weir on Staten Island		●	
10	Protective levee for home and barn on Staten Island*		●	
11	Protective levee for grain dryer on Staten Island		●	
12	Breach levee on northern tip of Staten Island		●	
13	Phase 3 Dredging			●
14	Internal detention levee(s) on Staten Island			●
15	Degrade Dead Horse Island east and southwest levees*			●

*Modeling and analysis is necessary to determine whether this component will be included in the alternative.

North Fork Detention

Alternative 2

Alternative 2 improves flood control with a setback levee to increase capacity on the north fork and detention basin off the North Fork Mokelumne River to detain peak flood flows (Figure 8 illustrates alternative 2 components and Table 4 lists all components of the alternative). The setback levee and detention area on the North Fork Mokelumne River are to mitigate for downstream impacts due to degrading M-W Tract levees.

The setback levee begins at the northern end of Staten Island and runs parallel to the North Fork until the River Field Gas Line, where an inlet weir would be constructed to divert flows to a detention basin that will be located on the northwest side of Staten Island. The proposed setback distance is 500 feet, but refined modeling of this alternative may show

that a shorter setback distance will provide sufficient capacity. The detention basin capacity would be designed based on the 1997 flood event (Note: DWR Flood Management staff is performing an analysis to verify that this event is less than the statistical 100 year flood event as it relates to FEMA floodplain mapping). The required acreage for the detention basin has not yet been determined. Additional HEC-RAS modeling will be done to size the basin for the 1997 event while minimizing required acreage and frequency of inundation. Once all the details of the detention basin size, weir elevation and length have been determined, an appendix in addition to this report will detail the detention basin configuration. In the event that the basin fills, permanent or portable pumps would operate to pump the water out of the detention basin after the flood event.

The proposed setback levee on the North Fork would most likely require the county road to be raised and/or realigned. Replacement of Millers Ferry Bridge would be necessary if modifications are made to the existing roadway. A protective levee around the home and barn on Staten are necessary for this alternative to protect existing infrastructure on Staten Island, unless another option becomes available, such as relocation.

Table 4: Alternative 2 Components

COMPONENT DESCRIPTION	
1	KCRA-3 protective levee
2	Degrade M-W Tract east and southwest levees
3	Raise/realign county road on Staten Island
4	Millers Ferry Bridge replacement
5	Protective levee for home and barn on Staten Island
6	Setback levee on North Fork Mokelumne River
7	Detention basin off the North Fork Mokelumne River
8	Pumps for detention basin waters
9	Inlet weir to detention basin
10	Degrade Dead Horse Island east and southwest levees*

*Modeling and analysis is necessary to determine whether this component will be included in the alternative.

Alternative 2D

Alternative 2D is comprised of all components specified in alternative 2 and dredging. The benefits of including dredging as a flood control component are that the alternative has the potential to be phased and a smaller detention area than alternative 2 is necessary due to increased channel capacity from dredging. A drawback of including dredging and sizing the detention basin smaller than in alternative 2 is that dredging to increase channel capacity is a solution that may not last the entire project life and there are no assurances that additional dredging permits will be approved to maintain the necessary channel capacities to meet flood control goals.

It is proposed that alternative 2D be implemented through phasing with a maximum of three project phases prior to completion (Refer to Table 5). Viability of proposed project phasing needs to be verified through HEC-RAS modeling as each phase must adequately

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address hydraulic impacts. Components of each phase are specified in Table 5 in the necessary order of completion.

Dredging would increase channel capacity in locations where sedimentation has occurred, thus reducing channel capacity. Dredging details are identical to those in alternative 1D and an additional source of dredge information is in Appendix A.

Table 5: Alternative 2D Components and Project Phasing

	COMPONENT DESCRIPTION	PROJECT PHASE		
		1	2	3
1	Phase 1 dredging	•		
2	KCRA-3 protective levee	•		
3	Degrade M-W Tract east and southwest levees	•		
4	Raise/realign county road on Staten Island		•	
5	Millers Ferry Bridge replacement		•	
6	Protective levee for home and barn on Staten Island		•	
7	Setback levee on North Fork Mokelumne River		•	
8	Detention basin off the North Fork Mokelumne River		•	
9	Pumps for detention basin waters		•	
10	Inlet weir to detention basin		•	
11	Phase 3 dredging			•
12	Degrade Dead Horse Island east and southwest levees*			•

*Modeling and analysis is necessary to determine whether this component will be included in the alternative.

South Fork Detention

Alternative 3

Alternative 3 is comprised of all common components and a setback levee and detention basin on the South Fork Mokelumne River (Refer to Table 6 for a list of all components. This alternative is illustrated in Figure 9. The setback levees on the South Fork of the Mokelumne River begin at the northern end of Staten and run parallel to the river at a distance TDB from the channel until the middle of New Hope Tract, where an inlet weir would be constructed to divert flows to a detention basin. The detention basin is located on the northeast portion of Staten to pull off flows from the river.

The required acreage for the detention basin has not yet been determined. Additional HEC-RAS modeling will be done to size the basin for the 1997 event while minimizing required acreage and frequency of inundation. Once all the details of the detention basin size, weir elevation and length have been determined, an appendix in addition to this report will detail the detention basin configuration. In the event that the basin fills, permanent or portable pumps would operate to pump the water out of the detention basin after the flood event.

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The county road on the northern tip of Staten Island would have to be relocated and/or raised to accommodate for the setback levee. New Hope Bridge replacement is specified in this alternative to allow the setback levee and changes in the county road. Also, replacement of the existing bridge with a higher bridge would alleviate a historic constriction point on the South Fork Mokelumne River. A protective levee around the grain dryer on Staten is necessary for this alternative to protect existing infrastructure on Staten Island from water in the South Fork detention basin, unless another option becomes available, such as relocation.

Table 6: Alternative 3 Components

	COMPONENT DESCRIPTION
1	KCRA-3 protective levee
2	Degrade M-W Tract east and southwest levees
3	Raise/realign county road on Staten Island
4	New Hope Bridge replacement
5	Protective levee for grain dryer on Staten Island
6	Setback levee on South Fork Mokelumne River
7	Detention basin off the South Fork Mokelumne River
8	Pumps for detention basin waters
9	Inlet weir to detention basin
10	Degrade Dead Horse Island east and southwest levees*

*Modeling and analysis is necessary to determine whether this component will be included in the alternative.

Alternative 3D

Alternative 3D is comprised of all components specified in alternative 3 and dredging. Detail on the benefits of dredging is explained in alternative 1D.

It is proposed that alternative 3D be implemented through phasing with a maximum of three project phases prior to completion (Refer to Table 7). Viability of proposed project phasing needs to be verified through HEC-RAS modeling as each phase must adequately address hydraulic impacts. Components of each phase are specified in Table 7 in the necessary order of completion.

Dredging would increase channel capacity in locations where sedimentation has occurred, thus reducing channel capacity. Dredging details are identical to those in alternative 1D and an additional source of dredge information is in Appendix A.

Table 7: Alternative 3D Components and Project Phasing

	COMPONENT DESCRIPTION	PROJECT PHASE		
		1	2	3
1	Phase 1 dredging	●		
2	KCRA-3 protective levee	●		
3	Degrade M-W Tract east and southwest levees	●		
4	Raise/realign county road on Staten Island		●	
5	New Hope Bridge replacement		●	
6	Protective levee for grain dryer on Staten Island		●	
7	Setback levee on South Fork Mokelumne River		●	
8	Detention basin off the South Fork Mokelumne River		●	
9	Pumps for detention basin waters		●	
10	Inlet weir to detention basin		●	
11	Phase 3 dredging			●
12	Degrade Dead Horse Island east and southwest levees*			●

*Modeling and analysis is necessary to determine whether this component will be included in the alternative.

Alternative 4- Dredging and Levee Raising (to be refined after HEC-RAS modeling)

This alternative consists of all components in the Common Components subsection, the maximum dredge bounds detailed in Appendix A (dredging would not be phased in the alternative) and raising downstream levees to mitigate for impacts not addressed by dredging (Refer to Figure 10). If modeling shows that dredging alone would not address downstream impacts, setback levees would be included in this alternative to the extent that it is not cost prohibitive. The fill material estimates associated with levee raising will be calculated once additional HEC-RAS models are performed to determine the required levee raise to offset downstream stage impacts. Table 8 lists alternative 4 components.

Table 8: Alternative 4 Components

	COMPONENT DESCRIPTION
1	KCRA-3 protective levee
2	Dredging (maximum dredge bounds)
3	Levee raising
4	Degrade M-W Tract east and southwest levees
5	Setback levees on North & South Fork Mokelumne River*
6	Degrade Dead Horse Island east and southwest levees*

*These components still have to be evaluated further

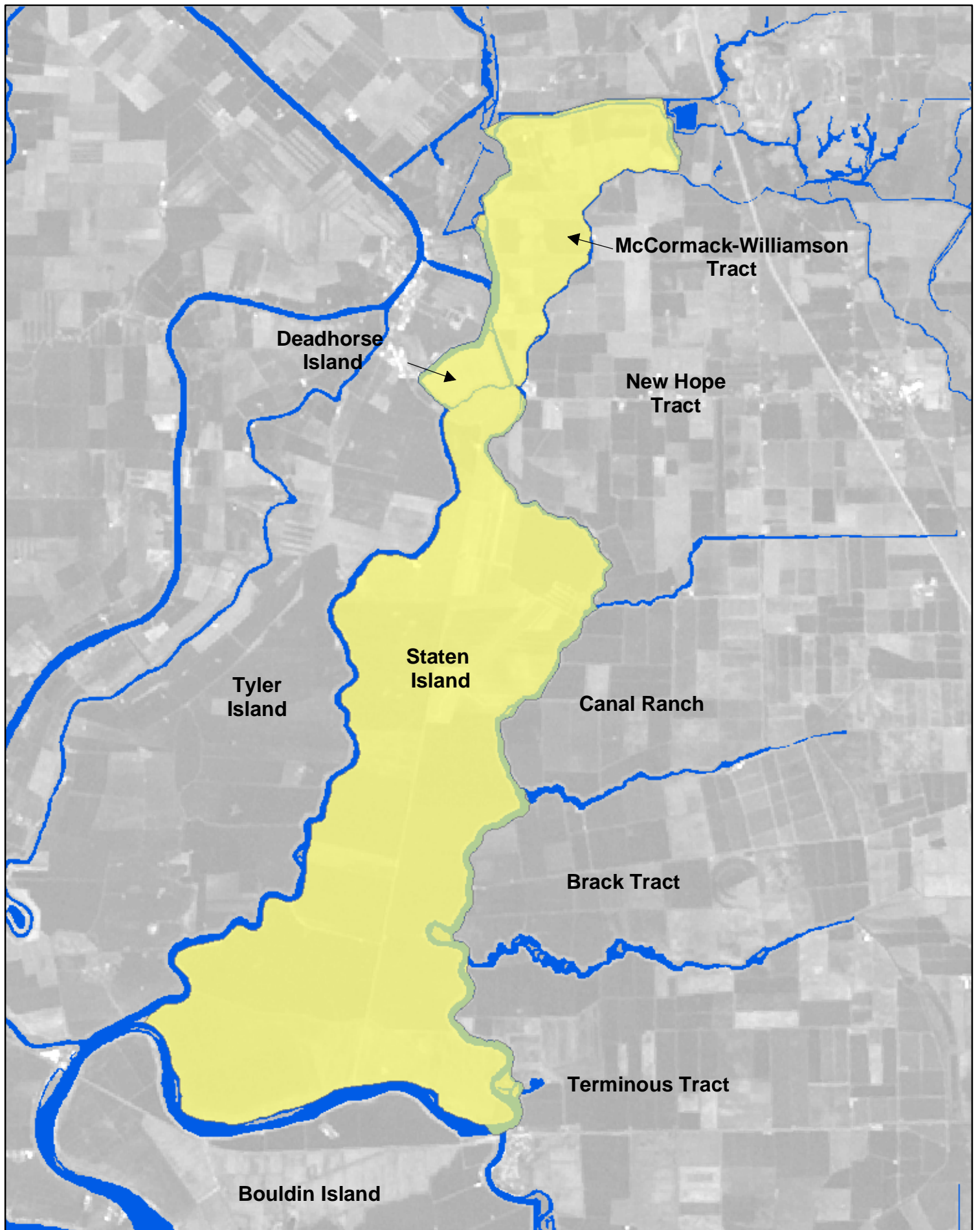


Figure 1: North Delta Flood Control and Ecosystem Restoration Project Area



Figure 4: KCRA-3 Property Protective Levee Alignments

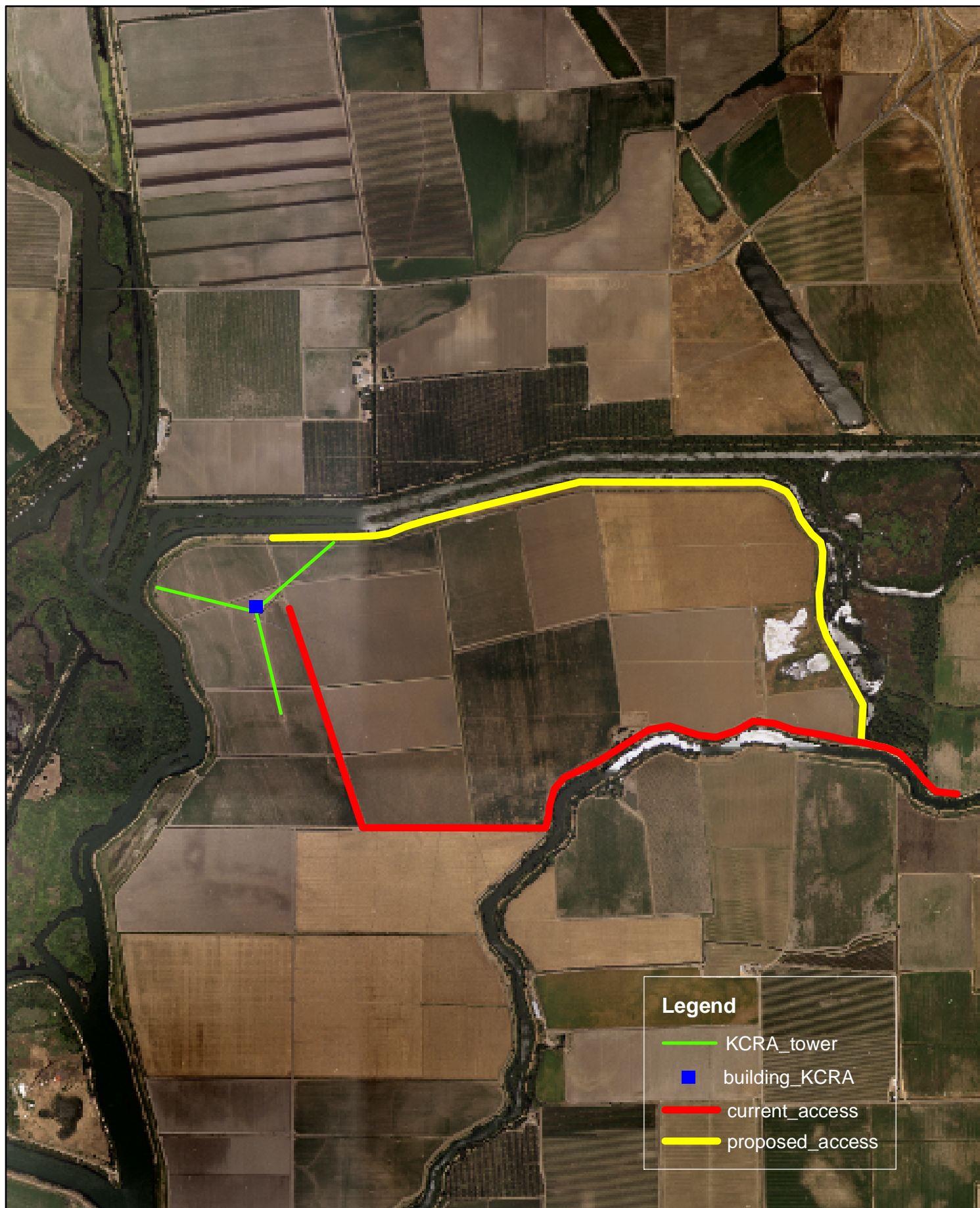


Figure 5: Current and Proposed KCRA-3 Road Access



Figure 6: Location of Lowest Levee Elevation along Mokelumne River Levee

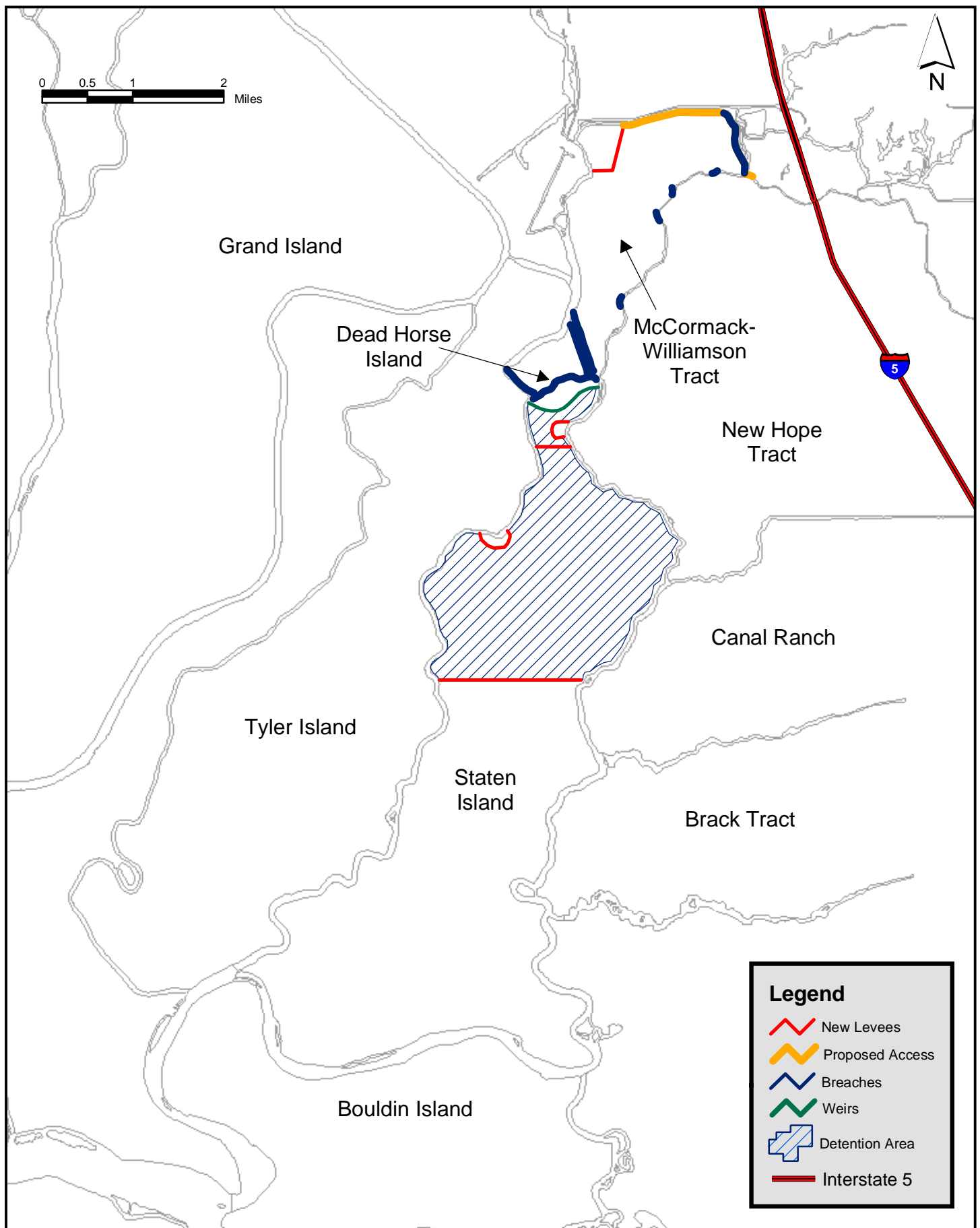


Figure 7: Alternative 1 - North Staten Island Detention

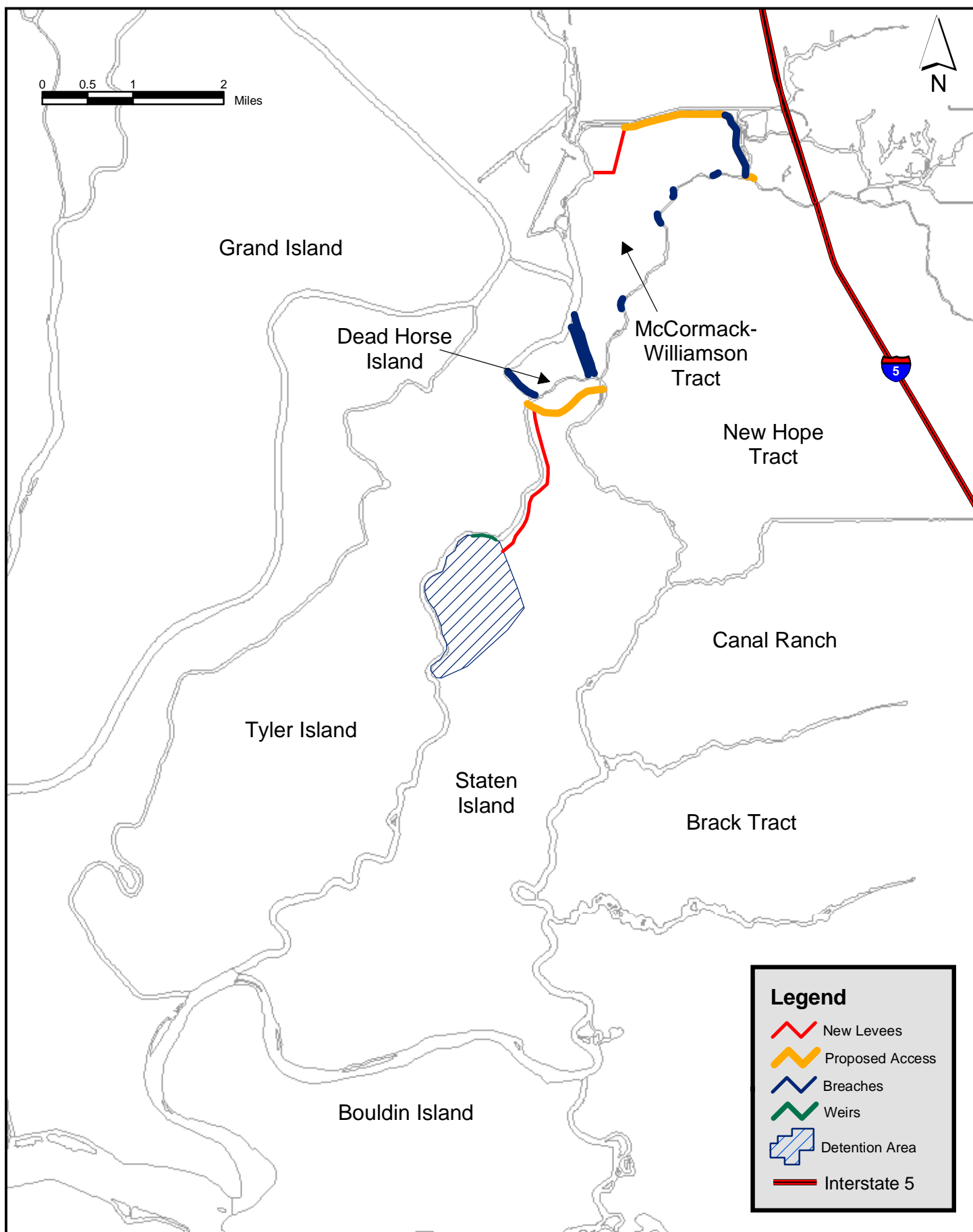


Figure 8: Alternative 2 - North Fork Detention

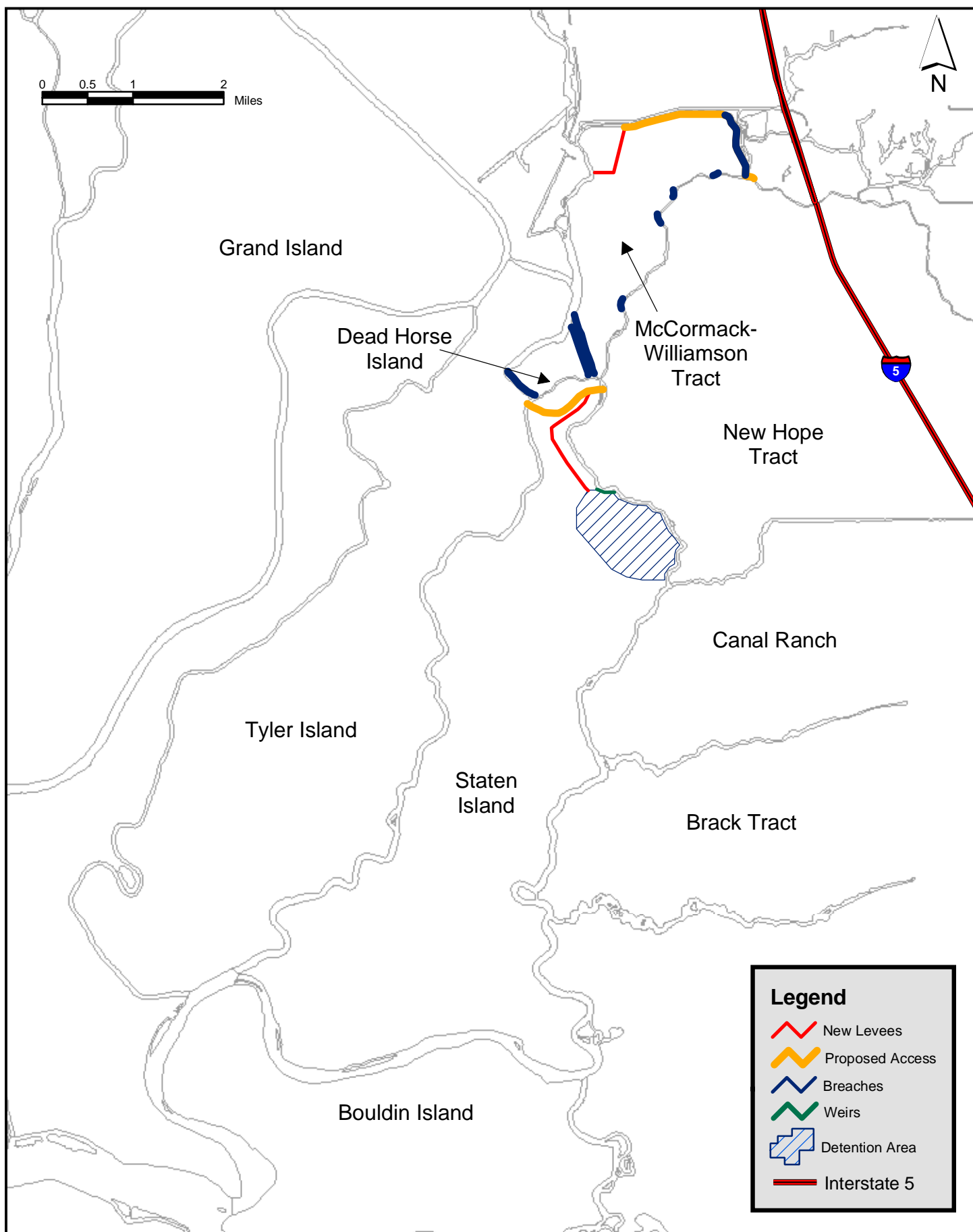


Figure 9: Alternative 3 - South Fork Detention

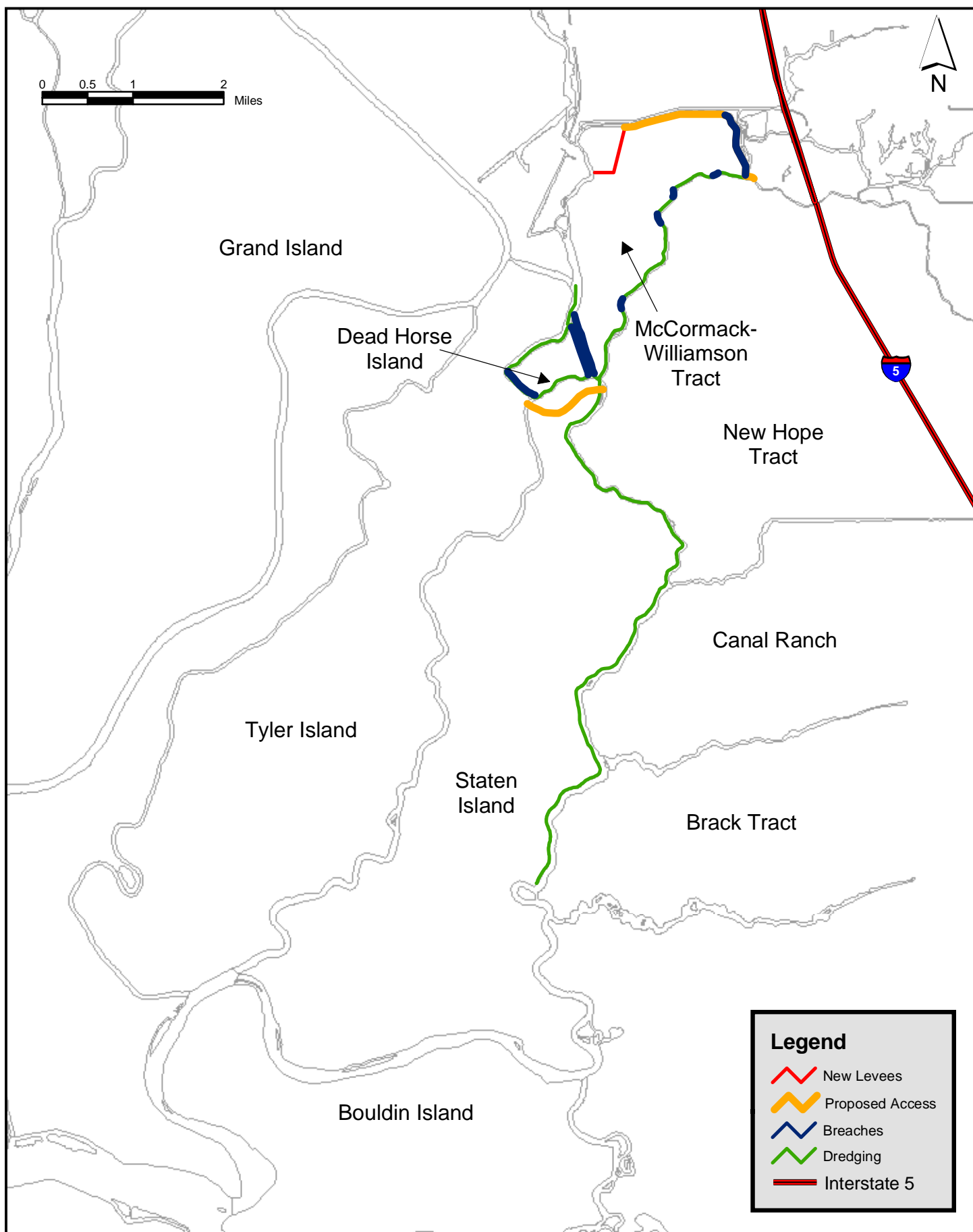


Figure 10: Alternative 4 - Dredging & Levee Raising

Appendix A
Dredge Information

Appendix A1: Summary

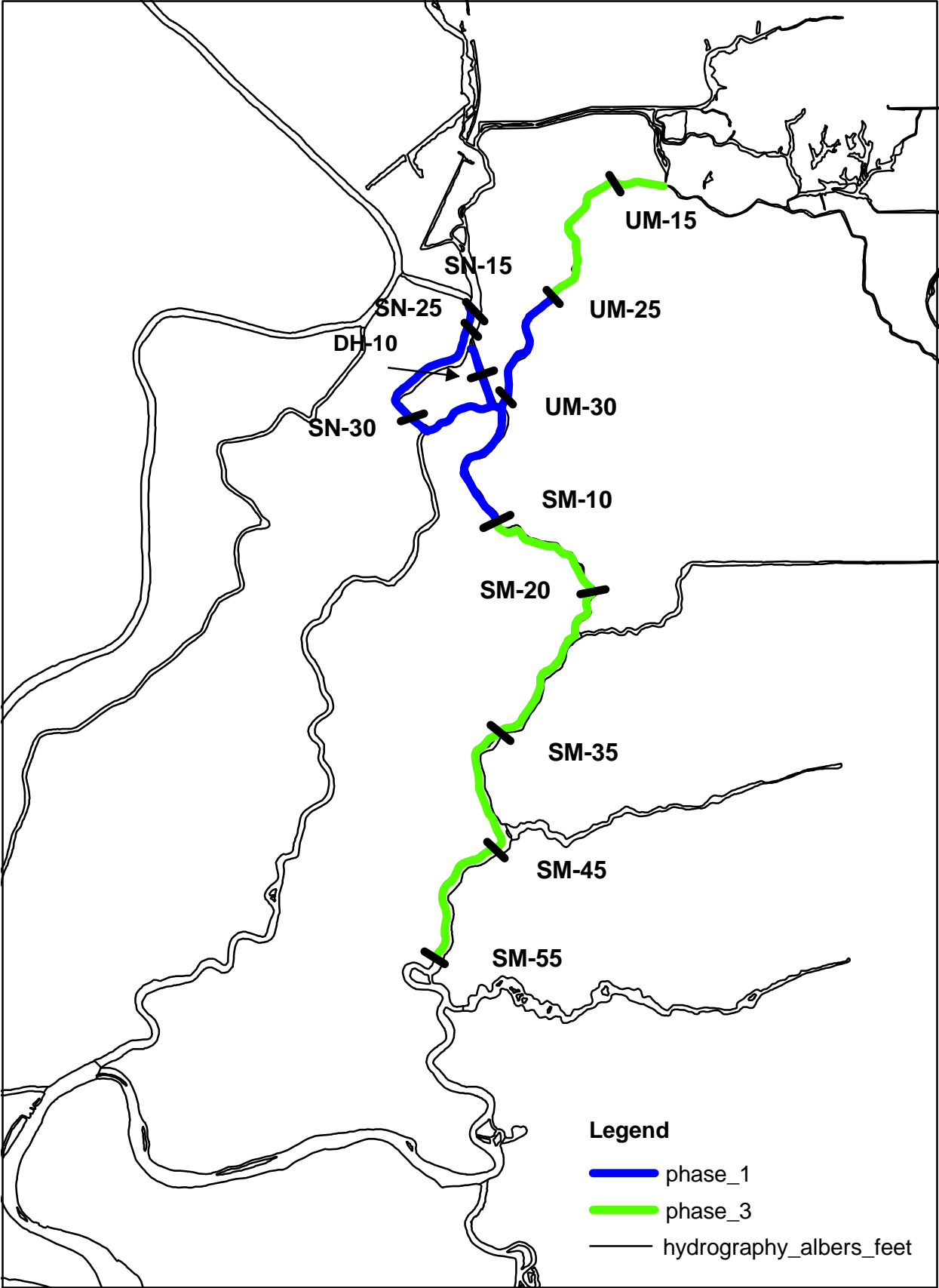
This appendix details the rationale for including dredging as a component of alternative 1D, 2D, 3D and 4 and methodology for calculating rough dredge quantity estimates for the alternatives. The maximum dredging bounds and quantities are the same for all alternatives where dredging applies, and the component is to increase channel capacity in locations where there is insufficient capacity. The dredged material is to be used for levee construction and ecosystem restoration. It is estimated between 5 and 9 million cubic yards of material could be dredged, within the project area bounds shown in Appendix A2.

Background on the North and South Fork Mokelumne Rivers will explain the rationale of incorporating a dredging component into each alternative. The 100 year event requires 90,000 cfs capacity in the North and South Fork combined. The current combined channel capacity is approximately 40,000 cfs and the flow split is 2/3 North Fork and 1/3 South Fork. Sediment deposition occurs on the South Fork channel, which decreases channel capacity. A decrease in channel capacity alters the natural flow split between the North and South Fork, causing scour on the North Fork from increased velocities. The North Delta Scour Monitoring Report indicates that the North Fork channels increased by 5%-47%, on average 17% within 6 years, whereas areas of the mainstem Mokelumne, South Fork and Snodgrass Slough have experienced sedimentation between 1994-2000.

Assumptions and guidelines specified in the 1990 EIR/EIS were considered in these estimates. Cross sectional areas along Snodgrass Slough and both the North and South Fork Mokelumne River greater than 8000 ft² were not considered for dredging. A cross sectional area of 20,000 ft² or more along the lower Mokelumne River was also not considered for dredging. Dredging is not to be done past 20 ft below mean sea level, and existing channel slopes are to be maintained where possible. These estimates do not maintain existing channel slopes in all dredge locations and will need to be refined.

The most recent data available was used to calculate areas within the project to be dredged (Refer to Appendix A2 for Dredge locations). The North Delta Scour Monitoring Program monitors several channel cross sections in the North Delta project area frequently. Cross sections monitored in the 1998-2000 report that correspond to this project's dredge locations are used in this analysis to determine the amount of material to be dredged for the North Delta Flood Control and Ecosystem Restoration Project. A compilation of levee data from the CALFED Levee Rehabilitation Study is the source of information for the calculation of additional channel capacity. Levees on both banks of the channel were evaluated and the shorter (with respect to mean sea level) was selected for analysis. Using the given waterside slope of the shorter levee, and assuming one foot of freeboard, the additional area at each representative cross section was calculated. The combined values is taken to be the channel capacity, and considered for dredging. The channel segments to be dredged were obtained with ARC GIS software and the hydrography data set on the GIS server. Using the trace tool, the segments to be dredged were matched with the channel, so that a relatively accurate length is computed.

Appendix A2: Dredge Locations



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Appendix A3: Calculation of Areas to be Dredged

Sediment Station	Existing X-sectional Area (ft²)	Island of Levee - Height of Levee (side 1 - ft)	Island of Levee - Height of Levee (side 2 - ft)	Existing Min. Levee Height (ft)	Channel width at mean sea-level (ft)	Existing Waterside slope (x on 1)	Additional X-area due to Levee	Total X-area (ft²)	Action
NM-10	1234	Staten - 14.9	Dead Horse - 9	9.0	125	2	1032	2266	Dredge
NM-30	4741	Staten - 12.8	Tyler - 14.9	12.8	350	2	4200	8940	None
NM-40	4392	Staten - 12.0	Tyler - 14.1	12.0	330	2	3691	8083	None
NM-50	4778	Staten - 11.1	Tyler - 13.4	11.1	330	2	3384	8162	None
NM-70	5969	Staten - 9.8	Tyler - 11.6	9.8	425	2	3779	9748	None
NM-75	6283	Staten - 9.8	Tyler - 11.1	9.8	335	2	2987	9270	None
NM-80	6914	Staten - 9.9	Tyler - 10.8	9.9	325	2	2932	9846	None
LM-50	8820	Bouldin - 9.6	Tyler - 9.6	9.6	850	2	7347	16167	Dredge
SM-10	1159	Staten - 14.6	New Hope - 14.7	14.6	210	2	2948	4107	Dredge
SM-20	1650	Staten - 12.9	New Hope - 12.4	12.4	175	2	2060	3710	Dredge
SM-35	2557	Staten - 10.8	Canal Ranch - 10.8	10.8	375	2	3723	6280	Dredge
SM-45	3844	Staten - 10	Brack Tract - 10	10.0	350	2	3191	7035	Dredge
SM-55	5246	Staten - 10	Brack Tract - 10	10.0	365	2	3326	8572	None
SN-10	2818	McCormack - 8	Not available	8.0	425	2	3000	5818	Dredge
SN-15	4271	McCormack - 8	Not available	8.0	575	2	4050	8320	None
SN-20	3975	McCormack - 8	Not available	8.0	430	2	3035	7009	Dredge
SN-25	3871	Dead Horse - 9	Not available	9.0	465	2	3752	7623	Dredge
SN-30	2876	Tyler - 16.1	Dead Horse - 9	9.0	225	2	1832	4708	Dredge
DH-10	1418	Dead Horse - 9	McCormack - 8	8.0	230	2	1635	3052	Dredge
UM-15	1347	McCormack - 8	New Hope - 19	8.0	125	2	900	2246	Dredge
UM-25	1200	McCormack - 8	New Hope - 16	8.0	145	2	1040	2239	Dredge
UM-30	1317	McCormack - 8	New Hope - 16	8.0	150	2	1075	2392	Dredge

Note: According to the 1990 North Delta EIR/EIS dredging is to be done to channels with cross-sectional areas less than 8000 ft² along the north and south forks of the Mokelumne River, 8000 ft² along Snodgrass Slough, and 20,000 ft² along the lower Mokelumne.

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Appendix A4: Dredge Quantities

Phase 1 Dredge Quantity

Channel Section	Monitored X-Sections	Segment Length (ft)	Deficient X-Section (ft ²)	Dredge Quantity (yd ³)
Mainstem & South Fork Mokelumne	UM-25, UM-30, SM-10	14646	5,087	2,784,741
Snodgrass Slough	SN-15, SN-25, SN-30, NM-10	13603	2,271	1,154,463
Deadhorse Cut	DH-10	3027	4,948	559,757

4,498,962

Phase 3 Dredge Quantity

Channel Section	Monitored X-Sections	Segment Length (ft)	Deficient X-Section (ft ²)	Dredge Quantity (yd ³)
Mokelumne River	UM-15, UM-25	10550	5,757	2,270,043
South Fork Mokelumne	SM-10, SM-35, SM-45, SM-55	31046	2,059	2,389,537

4,659,580

Maximum Dredge Bounds

Channel Section	Monitored X-Sections	Segment Length (ft)	Deficient X-Section (ft ²)	Dredge Quantity (yd ³)
Mainstem & South Fork Mokelumne	UM-25, UM-30, SM-10	14646	5,087	2,784,741
Snodgrass Slough	SN-15, SN-25, SN-30, NM-10	13603	2,271	1,154,463
Deadhorse Cut	DH-10	3027	4,948	559,757
Mokelumne River	UM-15, UM-25	10550	5,757	2,270,043
South Fork Mokelumne	SM-10, SM-35, SM-45, SM-55	31046	1,986	2,304,428

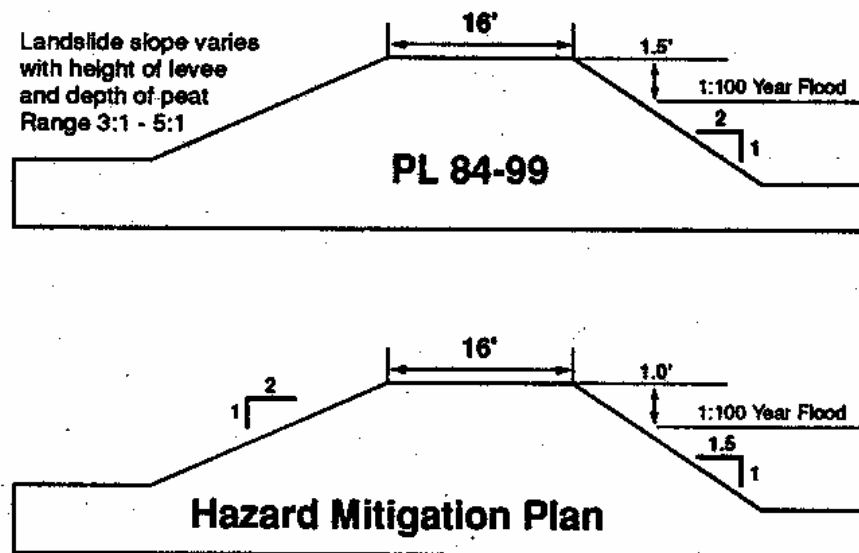
9,073,433

Appendix B
Fill Material Estimates

Appendix B1: Summary

The purpose of this appendix is to explain the methodology used to determine the quantities of fill material associated with the North Delta project alternatives. All alternatives require fill material for construction and material will also be retrieved from the degradation of levees. This estimate includes quantities associated with setback levees, protective levees and detention levees, as well as the amount of fill material available for use from degrading existing levees. This appendix is not yet completed. Calculations of fill material quantities will be included in the next draft document.

Many of the current projects in the Delta are required design the project levees to either Hazardous Mitigation Plan (HMP) or PL84-99 standards. HMP standards specify elevation of the levee to be 1' above 100 year flood stages, a crown width of at least 16', and waterside and landside slopes of 1.5:1 and 2:1, respectively. PL84-99 standards are more conservative and require the levee elevation to be 1.5' above 100 year flood stages, a crown width of 16' and waterside and landside slopes of 2:1 and 3:1, respectively. The estimates are a range of quantities for each structure since the standards we will be held to are still unknown. The following has been assumed necessary for each new levee; three access ramps per levee mile (1000 cubic yards of fill material per ramp), and settlement (peat) factor of 1.25 for levees on M-W Tract and 2 for levees on Staten Island.



Graphic courtesy of CALFED Levee System Integrity Program Plan, 2000

1997 peak stage values from the North Delta HEC-RAS model (baseline conditions) are treated as 100 year flood elevations and used to calculate the quantity of fill material needed for North Delta project levees, when it is necessary for a levee to meet HMP or PL84-99 standards. This is assuming that the '97 flood is near the 100 year flood event, and that no alternative is to change the 100 year floodplain. The peak stage value used to

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calculate levee elevation is the stage at an index point near the proposed levee (Refer to [Appendix B2](#) for a base map including index point locations). Refinement will be necessary if 100 year water surface elevations from synthetic hydrology become available or FEMA revises the 100 year floodplain in and around the project area. Once all modeling of alternatives have been refined, fill estimates should be based on 1997 peak stage values for each alternative. This will most likely reduce the quantity of fill material needed for project construction.

Some of the proposed levees do not need to meet HMP or PL84-99 standards. In most cases, the required elevation of the proposed levee is still unknown. Further research and negotiations are needed. In these cases, quantities are not specified. However, the methodology is stated and refinement will occur prior to the completion of the EIR EIS document.

Levee and ground surface elevations (GSE's) used to calculate fill estimates are contours generated from LIDAR data that reside on the DWR GIS server. Levee and GSE's vary, so average elevations are used when appropriate. It should be noted that there are holes in this data, specifically on McCormack-Williamson (M-W) Tract. Therefore, elevations used to compute quantities on M-W Tract should be revisited once the LIDAR data is refined. Existing and proposed levee lengths were either acquired using GIS tools or the length specified in the HEC-RAS model was used.

Setback Levees (Alternatives 2 & 3)

Setback levees are included in project alternatives 2 & 3 to improve conveyance at points in the system that are considered to be "bottlenecks". Setbacks are being considered along the North and South Fork Mokelumne River. The elevation of the setback levee on the N. Fork is based on an average of '97 flood stages at index points 10, 11, and 12 and the elevation of the setback levee on the S. Fork is determined by '97 flood stages at index points 5 & 6. The low estimate for both assumes a crown width of 16' and a levee elevation of 1' above the corresponding '97 flood stage, whereas the high cost assumes a crown width of 20' and elevation of 1.5' above the '97 flood stage. We are currently working with technical staff to refine appropriate slope and other cross section assumptions

Protective Levees

Implementation of project alternatives may affect existing properties and/or structures during flood events. Protective levees for existing properties/structures are included to mitigate for project implementation.

Grain Dryer and Home & Barn Levee (Alternative 1 & 2)

A grain dryer, home and barn are located on the northern portion of Staten Island. The grain dryer will be protected by a levee and the home and barn by another. Both levee elevations are a function of peak stage at index point 18.

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The low estimate of each protective levee meets PL84-99 standards, with a 16' crown width, levee elevation 1.5' above '97 flood stage and waterside and landside slopes of 3:1 and 4:1, respectively.

The high estimate is a more conservative levee that provides 5' of freeboard (above the '97 flood stage) to account for wave action, 20' crown width, 10:1 slopes on both sides from levee toe to levee midpoint, waterside slope of 3:1 and landside slope of 4:1 from levee midpoint to top of levee.

KCRA Ring Levee (All Alternatives)

A ring levee around the transmission tower and building on the leased property ultimately will be provided at a ten year level of protection. The current ring levee estimates are much higher because the design provides for betterment (~100 year level of protection). Once the necessary elevations are available, the fill material estimate for the ring levee will be refined to reflect a ten year level of protection.

Kirkham Berm (All Alternatives)

The Kirkham Property may require a berm to mitigate for increased stages due to the removal of a portion of the Mokelumne levee to incorporate branching channels into each alternative. It is anticipated that a berm will be placed around the property at the height of the low point on the Mokelumne levee (8.5').

Detention Levees (Alternatives 1, 2 & 3)

Alternatives 1, 2 & 3 mitigate for downstream impacts with a detention area on Staten Island. The low estimate of each protective levee meets PL84-99 standards, with a 16' crown width, levee elevation 1.5' above '97 flood stage and waterside and landside slopes of 3:1 and 4:1, respectively. The high estimate is a more conservative levee that provides 5' of freeboard (above the '97 flood stage) to account for wave action, 20' crown width, 10:1 slopes on both sides from levee toe to levee midpoint, waterside slope of 4:1 and landside slope of 5:1 from levee midpoint to top of levee. The slopes are more conservative since the detention is on Staten Island, which is located on large depths of organic soils. The shallower slopes will cause less settlement.

Levee Degradation (All Alternatives)

M-W Tract and Deadhorse Island, and Mokelumne River levees are breached in each alternative. These are potential borrow sites for fill material. Rough estimates of the quantity of material that may be available for borrow will be provided in the next draft document. As stated before, existing levee and GSE's were obtained from LIDAR data. The graphic below illustrates the volume of material to be calculated as available for borrow.

